WEST Search History

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DATE: Monday, May 14, 2007

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☐	L1	((invert$3 or inversion) with (sensitivity adj matrix))	62

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Search Results - Record(s) 1 through 33 of 33 returned.

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1. Document ID: US 20070103156 A1

L2: Entry 1 of 33 File: PGPB May 10, 2007

PGPUB-DOCUMENT-NUMBER: 20070103156
PGPUB-FILING-TYPE:
DOCUMENT-IDENTIFIER: US 20070103156 A1

TITLE: Mr imaging with sensitivity encoding in the readout direction

PUBLICATION-DATE: May 10, 2007

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Katscher; Ulrich	Norderstedt	OH	DE
Loncar; Mark J.	Mentor	OH	US
Thompson; Michael R.	Cleveland Heights		US

US-CL-CURRENT: 324/309; 324/307, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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2. Document ID: US 20050212517 A1

L2: Entry 2 of 33 File: PGPB Sep 29, 2005

PGPUB-DOCUMENT-NUMBER: 20050212517
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050212517 A1

TITLE: Reduction of susceptibility artifacts in subencoded single-shot magnetic resonance imaging

PUBLICATION-DATE: September 29, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Jaermann, Thomas	Zurich		CH
Pruessmann, Klaas Paul	Zurich		CH
Weiger, Markus	Kressbonn		CH
Schmidt, Conny Frauke	Zurich		CH
Boesiger, Peter	Ennetbaden		CH

US-CL-CURRENT: 324/307

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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3. Document ID: US 20050200357 A1

L2: Entry 3 of 33 File: PGPB Sep 15, 2005

PGPUB-DOCUMENT-NUMBER: 20050200357
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050200357 A1

TITLE: Magnectic resonance imaging

PUBLICATION-DATE: September 15, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Pruessmann, Klaas Paul	Zurich		CH
Weiger, Markus	Kressbonn		DE
Boesiger, Peter	Ennetbaden		CH

US-CL-CURRENT: 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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4. Document ID: US 20050189942 A1

L2: Entry 4 of 33 File: PGPB Sep 1, 2005

PGPUB-DOCUMENT-NUMBER: 20050189942
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050189942 A1

TITLE: Prior-information-enhanced dynamic magnetic resonance imaging

PUBLICATION-DATE: September 1, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Tsao, Jeffrey	Basel		CH
Pruessmann, Klaas Paul	Zurich		CH
Boesiger, Peter	Ennetbaden		CH

US-CL-CURRENT: 324/310; 324/307, 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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5. Document ID: US 20050174113 A1

L2: Entry 5 of 33 File: PGPB Aug 11, 2005

PGPUB-DOCUMENT-NUMBER: 20050174113
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20050174113 A1

TITLE: Magnetic resonance imaging method with accelerated data acquisition

PUBLICATION-DATE: August 11, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Tsao, Jeffrey	Basel		CH
Pruessmann, Klaas Paul	Zurich		CH
Boesiger, Peter	Ennetbaden		CH

US-CL-CURRENT: 324/307

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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6. Document ID: US 20040245987 A1

L2: Entry 6 of 33 File: PGPB Dec 9, 2004

PGPUB-DOCUMENT-NUMBER: 20040245987
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040245987 A1

TITLE: Magnetic resonance imaging method with reduced acoustic noise

PUBLICATION-DATE: December 9, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Ham, Cornelis Leonardus Gerardus	Eindhoven		NL
Harvey, Paul Royston	Eindhoven		NL

US-CL-CURRENT: 324/309; 324/307

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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7. Document ID: US 20040155652 A1

L2: Entry 7 of 33 File: PGPB Aug 12, 2004

PGPUB-DOCUMENT-NUMBER: 20040155652
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20040155652 A1

TITLE: Parallel magnetic resonance imaging techniques using radiofrequency coil arrays

PUBLICATION-DATE: August 12, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Sodickson, Daniel K.	Newton	MA	US

US-CL-CURRENT: 324/307; 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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8. Document ID: US 20030135104 A1

L2: Entry 8 of 33 File: PGPB Jul 17, 2003

PGPUB-DOCUMENT-NUMBER: 20030135104
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030135104 A1

TITLE: Magnetic resonance imaging method for an angulated cut plane

PUBLICATION-DATE: July 17, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Kouwenhoven, Marc	Eindhoven		NL

US-CL-CURRENT: 600/410

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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9. Document ID: US 20030122545 A1

L2: Entry 9 of 33 File: PGPB Jul 3, 2003

PGPUB-DOCUMENT-NUMBER: 20030122545
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20030122545 A1

TITLE: Magnetic resonance imaging method with a decay time function of sub-sampled acquisition data

PUBLICATION-DATE: July 3, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Van Den Brink, Johan	Eindhoven		NL
Hoogeveen, Romhild Martijn	Eindhoven		NL
Folkers, Paulus Johannes Maria	Eindhoven		NL

Pruessmann, Klaas Paul	Zurich	CH
Weiger, Markus	Zurich	CH

US-CL-CURRENT: 324/309; 324/307

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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10. Document ID: US 20020167316 A1

L2: Entry 10 of 33 File: PGPB Nov 14, 2002

PGPUB-DOCUMENT-NUMBER: 20020167316
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020167316 A1

TITLE: MRI image quality improvement using matrix regularization

PUBLICATION-DATE: November 14, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
King, Kevin F.	New Berlin	WI	US

US-CL-CURRENT: 324/307; 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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11. Document ID: US 20020158632 A1

L2: Entry 11 of 33 File: PGPB Oct 31, 2002

PGPUB-DOCUMENT-NUMBER: 20020158632
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020158632 A1

TITLE: Parallel magnetic resonance imaging techniques using radiofrequency coil arrays

PUBLICATION-DATE: October 31, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Sodickson MD Ph.D., Daniel K.	Cambridge	MA	US

US-CL-CURRENT: 324/307; 324/309, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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12. Document ID: US 20020128561 A1

L2: Entry 12 of 33 File: PGPB Sep 12, 2002

PGPUB-DOCUMENT-NUMBER: 20020128561
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020128561 A1

TITLE: Locating marker/tracer elements detectable by neutron activated analysis within or on carrier microspheres, including microspheres used in biological experimentation

PUBLICATION-DATE: September 12, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Rheinhardt, Christopher	Worcester	MA	US
Kemper, W. Scott	San Diego	CA	US

US-CL-CURRENT: 600/504; 600/3, 600/505

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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13. Document ID: US 20020111549 A1

L2: Entry 13 of 33 File: PGPB Aug 15, 2002

PGPUB-DOCUMENT-NUMBER: 20020111549
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020111549 A1

TITLE: Method for image generation by magnetic resonance

PUBLICATION-DATE: August 15, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Wang, Jianmin	Erlangen		DE

US-CL-CURRENT: 600/407

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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14. Document ID: US 20020089329 A1

L2: Entry 14 of 33 File: PGPB Jul 11, 2002

PGPUB-DOCUMENT-NUMBER: 20020089329
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020089329 A1

TITLE: Method for obtaining MRI images using sub-sampling in a vertical field MRI apparatus

PUBLICATION-DATE: July 11, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Harvey, Paul Royston	Eindhoven		NL
Van Helvoort, Marinus Johannes Adrianus Maria	Eindhoven		NL
Van Den Brink, Johan Samuel	Eindhoven		NL

US-CL-CURRENT: 324/309; 324/307, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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15. Document ID: US 20020039024 A1

L2: Entry 15 of 33 File: PGPB Apr 4, 2002

PGPUB-DOCUMENT-NUMBER: 20020039024
PGPUB-FILING-TYPE: new
DOCUMENT-IDENTIFIER: US 20020039024 A1

TITLE: Magnetic resonance imaging method with sub-sampled acquisition

PUBLICATION-DATE: April 4, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	COUNTRY
Fuderer, Miha	Eindhoven		NL
Van Den Brink, Johan Samuel	Eindhoven		NL
Jurrissen, Michel Paul Jurriaan	Eindhoven		NL
Van Muiswinkel, Arianne Margarethe Corinne	Eindhoven		NL
Katscher, Ulrich	Norderstedt		DE

US-CL-CURRENT: 324/307; 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | Sequences | Attachments | Claims | KWIC | Draw Desc | Image

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16. Document ID: US 7061240 B2

L2: Entry 16 of 33 File: USPT Jun 13, 2006

US-PAT-NO: 7061240
DOCUMENT-IDENTIFIER: US 7061240 B2

TITLE: Magnetic resonance imaging method with reduced acoustic noise

DATE-ISSUED: June 13, 2006

PRIOR-PUBLICATION:

DOC-ID	DATE
US 20040245987 A1	December 9, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Ham; Cornelis Leonardus Gerardus	Eindhoven			NL
Harvey; Paul Royston	Eindhoven			NL

US-CL-CURRENT: 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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17. Document ID: US 7035682 B2

L2: Entry 17 of 33 File: USPT Apr 25, 2006

US-PAT-NO: 7035682
DOCUMENT-IDENTIFIER: US 7035682 B2

TITLE: Magnetic resonance imaging method with a decay time function of sub-sampled acquisition data

DATE-ISSUED: April 25, 2006

PRIOR-PUBLICATION:

DOC-ID	DATE
US 20030122545 A1	July 3, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Van Den Brink; Johan	Eindhoven			NL
Hoogeveen; Romhild Martijn	Eindhoven			NL
Folkers; Paulus Johannes Maria	Eindhoven			NL
Pruessmann; Klaas Paul	Zurich			CH
Weiger; Markus	Dietikon			CH

US-CL-CURRENT: 600/420; 600/419

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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18. Document ID: US 7005853 B2

L2: Entry 18 of 33 File: USPT Feb 28, 2006

US-PAT-NO: 7005853
DOCUMENT-IDENTIFIER: US 7005853 B2

TITLE: Prior-information-enhanced dynamic magnetic resonance imaging

DATE-ISSUED: February 28, 2006

PRIOR-PUBLICATION:

DOC-ID DATE

US 20050189942 A1 September 1, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Tsao; Jeffrey	Basel			CH
Pruessmann; Klaas Paul	Zurich			CH
Boesiger; Peter	Ennetbaden			CH

US-CL-CURRENT: 324/309; 324/307, 324/318, 600/410

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 19. Document ID: US 6980002 B1

L2: Entry 19 of 33 File: USPT Dec 27, 2005

US-PAT-NO: 6980002
DOCUMENT-IDENTIFIER: US 6980002 B1

TITLE: Integrated cervical-thoracic-lumbar spine MRI array coil

DATE-ISSUED: December 27, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Petropoulos; Labros Spiridon	Burton	OH		
Zou; Mark Xueming	Mantua	OH		
Zheng; Tsinghua	Aurora	OH		

US-CL-CURRENT: 324/318; 324/309, 600/422

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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☐ 20. Document ID: US 6965232 B2

L2: Entry 20 of 33 File: USPT Nov 15, 2005

US-PAT-NO: 6965232
DOCUMENT-IDENTIFIER: US 6965232 B2

TITLE: Parallel magnetic resonance imaging techniques using radiofrequency coil arrays

DATE-ISSUED: November 15, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sodickson; Daniel K.	Newton	MA		

US-CL-CURRENT: 324/307; 324/309, 324/318, 600/410

Full	Title	Citation	Front	Review	Classification	Date	Reference			Claims	KWIC	Draw Desc	Image

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☐ 21. Document ID: US 6954069 B2

L2: Entry 21 of 33 File: USPT Oct 11, 2005

US-PAT-NO: 6954069
DOCUMENT-IDENTIFIER: US 6954069 B2

TITLE: Obtaining MRI images using sub-sampling in a vertical field MRI apparatus

DATE-ISSUED: October 11, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Harvey; Paul Royston	Eindhoven			NL
van Helvoort; Marinus Johannes Adrianus Maria	Eindhoven			NL
van den Brink; Johan Samuel	Eindhoven			NL

US-CL-CURRENT: 324/318; 324/322

Full	Title	Citation	Front	Review	Classification	Date	Reference			Claims	KWIC	Draw Desc	Image

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☐ 22. Document ID: US 6838879 B2

L2: Entry 22 of 33 File: USPT Jan 4, 2005

US-PAT-NO: 6838879
DOCUMENT-IDENTIFIER: US 6838879 B2

TITLE: Magnetic resonance imaging method for an angulated cut plane with respect to a reference frame

DATE-ISSUED: January 4, 2005

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Kouwenhoven; Marc	Eindhoven			NL

US-CL-CURRENT: 324/309

Full	Title	Citation	Front	Review	Classification	Date	Reference			Claims	KWIC	Draw Desc	Image

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☐ 23. Document ID: US 6717406 B2

L2: Entry 23 of 33 File: USPT Apr 6, 2004

US-PAT-NO: 6717406

DOCUMENT-IDENTIFIER: US 6717406 B2

TITLE: Parallel magnetic resonance imaging techniques using radiofrequency coil arrays

DATE-ISSUED: April 6, 2004

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Sodickson; Daniel K.	Newton	MA		

US-CL-CURRENT: 324/307; 324/309, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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24. Document ID: US 6650925 B2

L2: Entry 24 of 33 File: USPT Nov 18, 2003

US-PAT-NO: 6650925
DOCUMENT-IDENTIFIER: US 6650925 B2

TITLE: Method for image generation by magnetic resonance

DATE-ISSUED: November 18, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Wang; Jianmin	Erlangen			DE

US-CL-CURRENT: 600/410; 324/307, 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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25. Document ID: US 6593740 B1

L2: Entry 25 of 33 File: USPT Jul 15, 2003

US-PAT-NO: 6593740
DOCUMENT-IDENTIFIER: US 6593740 B1

TITLE: Magnetic resonance imaging method with a decay time function of sub-sampled acquisition data

DATE-ISSUED: July 15, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Van Den Brink; Johan	Eindhoven			NL
Hoogeveen; Romhild Martijn	Eindhoven			NL
Folkers; Paulus Johannes Maria	Eindhoven			NL

Pruessmann; Klaas Paul	Zurich	CH
Weiger; Markus	Dietikon	CH

US-CL-CURRENT: 324/307; 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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26. Document ID: US 6518760 B2

L2: Entry 26 of 33 File: USPT Feb 11, 2003

US-PAT-NO: 6518760
DOCUMENT-IDENTIFIER: US 6518760 B2

TITLE: Magnetic resonance imaging method with sub-sampled acquisition

DATE-ISSUED: February 11, 2003

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Fuderer; Miha	Eindhoven			NL
Van Den Brink; Johan Samuel	Eindhoven			NL
Jurrissen; Michel Paul Jurriaan	Eindhoven			NL
Van Muiswinkel; Arianne Margarethe Corinne	Eindhoven			NL
Katscher; Ulrich	Norderstedt			DE

US-CL-CURRENT: 324/307; 324/309, 324/318

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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27. Document ID: US 6486671 B1

L2: Entry 27 of 33 File: USPT Nov 26, 2002

US-PAT-NO: 6486671
DOCUMENT-IDENTIFIER: US 6486671 B1

TITLE: MRI image quality improvement using matrix regularization

DATE-ISSUED: November 26, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
King; Kevin F.	New Berlin	WI		

US-CL-CURRENT: 324/307; 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

28. Document ID: US 6377045 B1

L2: Entry 28 of 33 File: USPT Apr 23, 2002

US-PAT-NO: 6377045
DOCUMENT-IDENTIFIER: US 6377045 B1

TITLE: Magnetic resonance imaging method with sub-sampling

DATE-ISSUED: April 23, 2002

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Van Den Brink; Johan Samuel	Eindhoven			NL
Lamerichs; Rudolf Mathias Johannes Nicolaas	Eindhoven			NL
Folkers; Paulus Johannes Maria	Eindhoven			NL
Van Muiswinkel; Arianne Margarethe Corinne	Eindhoven			NL
Pruessmann; Klaas Paul	Zurich			CH
Weiger; Markus	Dietikon			CH
Dydak; Ulrike	Zurich			CH

US-CL-CURRENT: 324/307; 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

29. Document ID: US 6328700 B1

L2: Entry 29 of 33 File: USPT Dec 11, 2001

US-PAT-NO: 6328700
DOCUMENT-IDENTIFIER: US 6328700 B1

TITLE: Locating marker/tracer elements detectable by neutron activated analysis within or on carrier microspheres, including microspheres used in biological experimentation

DATE-ISSUED: December 11, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Rheinhardt; Christopher	Worcester	MA	01601	
Kemper; W. Scott	San Diego	CA	92129	

US-CL-CURRENT: 600/504; 600/3, 600/505

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

30. Document ID: US 6326786 B1

L2: Entry 30 of 33 File: USPT Dec 4, 2001

US-PAT-NO: 6326786
DOCUMENT-IDENTIFIER: US 6326786 B1

TITLE: Magnetic resonance imaging method and apparatus

DATE-ISSUED: December 4, 2001

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Pruessmann; Klaas P.	Zurich			CH
Weiger; Markus	Dietikon			CH
Scheidegger; Markus B.	Bisikon			CH
Boesiger; Peter	Ennetbaden			CH

US-CL-CURRENT: 324/312; 324/309

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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31. Document ID: US 4284950 A

L2: Entry 31 of 33 File: USPT Aug 18, 1981

US-PAT-NO: 4284950
DOCUMENT-IDENTIFIER: US 4284950 A

TITLE: Imaging systems

DATE-ISSUED: August 18, 1981

INVENTOR-INFORMATION:

NAME	CITY	STATE	ZIP CODE	COUNTRY
Burl; Michael	Iver			GB2
Clow; Hugh	Reading			GB2
Harrison; Colin G.	High Wycombe			GB2
Young; Ian R.	Sunbury-on-Thames			GB2

US-CL-CURRENT: 324/320; 324/313

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

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32. Document ID: WO 9954746 A1

L2: Entry 32 of 33 File: EPAB Oct 28, 1999

PUB-NO: WO009954746A1
DOCUMENT-IDENTIFIER: WO 9954746 A1
TITLE: MAGNETIC RESONANCE IMAGING METHOD AND APPARATUS

Full | Title | Citation | Front | Review | Classification | Date | Reference | | | Claims | KWIC | Draw Desc | Image

33. Document ID: US 6486671 B1, US 20020167316 A1, EP 1260826 A2, JP 2002345780 A

L2: Entry 33 of 33 File: DWPI Nov 26, 2002

DERWENT-ACC-NO: 2003-166186
DERWENT-WEEK: 200316

TITLE: 2D slice image generation method for magnetic resonance imaging system, involves multiplying inverted sensitiveness matrix by intensity matrix to generate spin density matrix

Term	Documents
MAGNETIC	1739008
MAGNETICS	15903
MRI	39239
MRIS	621
NMR	179889
NMRS	312
RESONAN$2	0
RESONAN	1140
RESONANA	3
RESONANAE	3
(L1 AND ((MAGNETIC ADJ RESONAN$2) OR MRI OR NMR)).PGPB,USPT,USOC,EPAB,JPAB,DWPI,TDBD.	33

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L2: Entry 24 of 33 File: USPT Nov 18, 2003

DOCUMENT-IDENTIFIER: US 6650925 B2
TITLE: Method for image generation by magnetic resonance

Abstract Text (1):
In a method for image generation by magnetic resonance, a number of independent reception antennas having sensitivity profiles differing from one another are employed, and radio-frequency excitation pulses and gradient pulses are emitted into an imaging volume for generating location-coded magnetic resonance signals. The magnetic resonance signals are received with the reception antennas, and respective k-space data sets each having middle rows and outer rows are formed from the reception signals of the respective reception antennas. The middle k-space rows are more densely arranged than the outer k-space rows in the respective k-space data sets. An intermediate image is reconstructed from each k-space data set. The sensitivity profiles from the middle k-space data rows are determined and the intermediate images are combined dependent on the sensitivity profiles to form an overall image.

Brief Summary Text (3):
The present invention is directed to a method for generating an image by magnetic resonance, and in particular to such a method employing a number of reception antennas, for picking up magnetic resonance signals, the respective antennas having different sensitivity profiles.

Brief Summary Text (5):
In the measurement sequences for magnetic resonance imaging that have been standard, and employed with a given size and resolution of the imaging, the time required for generating a magnetic resonance image is defined by the intensity of the gradient magnetic field used for the topical resolution. The gradient coils with which the gradient magnetic field is generated are becoming increasingly powerful and the measurements are becoming increasingly faster as a result. However, a physiologically prescribed limit human tissue (stimulation limit) that cannot be transgressed exists because of the magnetic fields that are rapidly switched in such sequences and because of the electrical voltages that are thereby induced in the tissue of the patient.

Brief Summary Text (7):
Thus, the article by Hutchinson and Raff, "Fast MRI Data Acquisition Using Multiple Detectors", in Magnetic Resonance in Medicine, Vol. 6, pp. 87-91 (1988), describes a method wherein only one phase-coding step is required for producing an image. An antenna array having a number of independent individual antennas and radio-frequency channels is employed, the number corresponding exactly to the number of phase-coding steps given conventional, sequential phase-coding with phase-coding gradient fields. This method is difficult to employ because of the high number of required reception channels.

Brief Summary Text (10):
As reported in the article by J. B. Ra, C. Y. Rim, "Fast Imaging Using Sub-Encoding Data Sets from Multiple Detectors", in Magnetic Resonance in Medicine, Vol. 30, pp. 142-145, 1993, the method outlined above was tested at a phantom with a four-channel system. A speed-up of the measuring time with a factor of 4 was thereby achieved. A method also is described in this article with which the speed-up factor can be selected lower then the number of independent reception antennas.

Brief Summary Text (11):
A development of the fast imaging method described by Kelton et al and Ra/Rim is disclosed in

PCT Application WO 99/54746. The inverse sensitivity matrices required in the processing of the intermediate images are replaced in this version by generalized inverse sensitivity matrices. For defining the sensitivity profiles required for the reconstruction of the ultimate image, a reference measurement having the same or a lower resolution as in the actual image production is implemented before the actual registration. To that end, the magnetic resonance signals are measured with the individual antennas in the antennas array as well as with the whole-body antenna permanently installed in the magnetic resonance apparatus. The sensitivity profile of the whole-body antenna is constant enough in order to be able to be used as a reference. The complex images (in the mathematical sense) of the individual antennas obtained after the Fourier transformation and the reference image of the whole body antenna are placed into relationship with one another, and the complex sensitivity profiles (in the mathematical sense) of the individual antennas are obtained. These are then employed for the reconstruction in the following, actual measurement. A disadvantage of this version is that the required measuring time is lengthened by the "pre-scan". It generally applies in the measurement of magnetic resonance images that the signal-to-noise ratio is proportional to the square root of the measurement time. Since the pre-scan, however, is employed only in order to determine the sensitivity profiles of the individual antennas in the antenna array, the signal-to-noise ratio is not improved despite a lengthened measurement time. The relationship of the signal-to-noise ratio to the square root of the measurement time is poorer in this version than in conventional methods when the measurement time required for the pre-scan is also taken into consideration.

Brief Summary Text (12):
U.S. Pat. No. 5,910,728 discloses another method with which the measurement time can be reduced by omitting phase-coding steps. An antenna array having independent individual antennas is also employed therein. The reconstruction of the missing phase-coding steps ensues, however, in the spatial frequency domain (k-space) and not in the image space as in the above methods. Due to the specific type of reconstruction of the missing k-space rows, this method is also called SMASH (simultaneous acquisition of special harmonics). It is assumed, however, that the sensitivity profiles of the individual antennas do not vary greatly in the frequency coding direction. Another pre-requisite for a convolution-free reconstruction of a magnetic resonance image is an exact knowledge of the sensitivity profiles of the individual antennas employed. Since the sensitivity profiles are also patient-dependent, they must usually be measured with each patient in the examination position.

Brief Summary Text (13):
In the method described in the article by P. M. Jakob, M. A. Griswold, R. R. Edelman, D. K. Sodickson, "AUTO SMASH: A self-calibrating technique for SMASH imaging", in 1998 in Magnetic Resonance Materials in Physics, Biology and Medicine, Vol. 7, pages 42-54, a calibration step with a corresponding phase-coding is implemented in addition to the reduced SMASH phase-coding steps. The sensitivity profiles of the individual antennas are determined therefrom during the measurement, and the correlation between the under-sampled SMASH signals and the additional calibration signals is analyzed.

Brief Summary Text (15):
An object of the present invention is to provide a method for fast image generation by means of magnetic resonance, whereby the sensitivity profiles of the individual antennas in the antenna array are determined in a simple way.

Brief Summary Text (16):
This object is achieved in accordance with the invention in a method for image generation by magnetic resonance, wherein a number of independent reception antennas having sensitivity profiles differing from one another are employed, and wherein in radio-frequency excitation pulses and gradient pulses are emitted into an imaging volume for generating location-coded magnetic resonance signals, the magnetic resonance signals are received with the reception antennas, with a k-space data set having middle and outer k-space rows being formed from the reception signals of each reception antenna, the middle k-space rows being more densely arranged than the outer k-space rows in the k-space data set, an intermediate image is reconstructed from each k-space data set, the sensitivity profiles are determined from the middle k-space data rows, and the intermediate images are combined dependent on the sensitivity profiles to form an overall image.

Brief Summary Text (18):
Individual images having a rough (coarse) resolution are then reconstructed from the magnetic resonance signals in the low spatial frequency range, these individual images being allocated to the corresponding individual antennas. Since the sensitivity profiles of the individual antennas are themselves mainly composed of low spatial frequency components, the information needed for determining the sensitivity profiles is thus completely identified. No additional information beyond the sensitivity profiles of the individual antennas is required.

Brief Summary Text (19):
The entire measurement time is lengthened somewhat as a result. The additional phase-coded magnetic resonance signals in the middle region of the k-space, however, can be employed for enhancing the signal-to-noise ratio, and thus for improving the imaging quality for the reconstruction of the individual images as well, and thus of the overall image. It is also a particular advantage that the sensitivity profiles are derived from the same measurement as the signals acquired for the actual image generation; this method therefore functions for determining the sensitivity profiles even given sequences with more pronounced topical distortion. One example of this is the EPI sequence (EPI is an abbreviation for echo planar imaging). It is known that image artifacts referred to as blurring artifacts or distortions occur given fast EPI sequences. Since the reference images exhibit the same distortions, the reconstruction also functions given more pronounced topical distortion.

Drawing Description Text (2):
FIG. 1 is an overall illustration showing the basic steps in the signal processing for fast magnetic resonance imaging in accordance with the inventive method.

Detailed Description Text (2):
FIG. 1 schematically shows a diagnostic magnetic resonance apparatus 2 having the known (and therefore not individually illustrated) components of a basic field magnet for generating a uniform magnetic field in an imaging volume 4, a gradient system for generating magnetic gradient fields in three spatial directions residing perpendicularly to one another, a radio-frequency antenna system for exciting and for receiving magnetic resonance signals, as well as a control unit for controlling the individual components in the magnetic resonance apparatus. Dependent on a selected sequence, the magnetic gradient fields are activated for location coding of the magnetic resonance signals at predetermined time intervals with a predetermined intensity. A distinction is made between a slice selection gradient, a phase code gradient and a frequency coding gradient. In many sequences, thus, only the nuclei in one layer are excited by the slice coding gradient field being simultaneously activated with a radio-frequency excitation pulse. A further location coding then ensues in the excited slice in phase-coding direction by activating the phase-coding gradient. The phase of the magnetic resonance signal is determined by the gradient time area of the phase-coding gradient. Finally, a frequency coding in a direction perpendicular to the phase-coding ensues upon reception of the magnetic resonance signal by activating the frequency coding gradient. The radio-frequency antenna system has a whole-body antenna that is fashioned for the excitation as well as for the reception of the magnetic resonance signals. Additionally, an antenna array 6 having individual antenna 6A, 6B, 6C, 6D independent of one another is present, these, in contrast to the whole-body antenna, each being capable of imaging only a limited area. This is exploited in a fast magnetic resonance imaging method with parallel data acquisition, whereby the location coding in phase-coding direction no longer need completely ensue with phase-coding gradients. These methods are known as described, for example, in the initially cited article by Kelton et al. The individual antennas 6A, 6B, 6C, 6D are respectively connected to independent radio-frequency channels 8A, 8B, 8C, 8D wherein an amplification, a phase-sensitive demodulation and a digitizing of the magnetic resonance signal respective received from the individual antennas 6A, 6B, 6C, 6D ensues.

Detailed Description Text (7):
Using the complex coil profiles 22 (in the mathematical sense) of the individual antennas 6A, 6B, 6C, 6D, a convolution-free overall image 26 of the examination region is generated from the intermediate images 20A, 20B, 20C, 20D in a reconstruction unit 24. The reconstruction method has been described elsewhere, for example in Kelton et al, and essentially involves determining

the values for the picture elements of the overall image 26 from the corresponding picture elements of all intermediate images 20A, 20B, 20C, 20D on the basis of a weighted summing. The weighting factors represent a matrix is derived by inversion from the complex sensitivity matrices of the individual antennas 6A, 6B, 6C, 6D.

Detailed Description Text (8):
The method for determining the complex sensitivity profiles of the individual antennas 6A, 6B, 6C, 6D is now explained with reference to FIG. 2. As set forth above, the phase-coding steps are selected in the generation of the magnetic resonance signals such that the middle region of each k-space 16A, 16B, 16C is completely occupied with values. Sensitivity intermediate images 25A, 25B, 25C, 25D having a coarse resolution are now reconstructed from the middle k-space rows. A sum image 28 that is used as a reference image is also formed from the individual sensitivity intermediate images 25A, 25B, 25C, 25D.

Detailed Description Text (12):
For illustrating the gain in measurement time to be achieved compared to a traditional signal acquisition, let a rectangular magnetic resonance image be generated as example having a resolution of 256 picture elements in the frequency coding direction and a resolution of 192 picture elements in the phase-coding direction. The individual phase-coding steps are selected, for example, such that k-space is completely occupied with 48 k-space rows in the low spatial frequency range. This corresponds to one-fourth of the k-space rows that would be required for a conventional convolution-free reconstruction. Outside of this middle region, the k-space is occupied with a plurality of rows reduced by the factor 2, this corresponding to a correspondingly reduced number of phase-coding steps. (196-48)/2=72 rows are thus generated.) The image reconstructed from the individual intermediate images (for example, four intermediate images) is convolution-free. The reduction in measurement time in this case amounts to 192/(72+48)=1.6. Compared to an image that is reconstructed from a completely occupied k-space, the signal-to-noise ratio (S/N) is only degraded by the factor 1.6.

Other Reference Publication (3):
"Fast Imaging Using Subencoding Data Sets From Multiple Detectors," Ra et al, Magnetic Resonance in Medicine, vol. 30 (1993), pp. 142-145..

CLAIMS:

1. A method for generating an image by magnetic resonance, comprising the steps of: emitting radio-frequency excitation pulses into an imaging volume for exciting nuclear magnetic resonance signals in said imaging volume; generating at least one gradient field in said imaging volume for location-coding said nuclear magnetic resonance signals to produce location-coded magnetic resonance signals; receiving said location-coded magnetic resonance signals with a plurality of independent reception antennas, each having a sensitivity profile, with the respective sensitivity profiles of said reception antennas differing from each other, said reception antennas respectively generating reception signals; generating a plurality of k-space data sets respectively from the reception signals from the plurality of reception antennas, each k-space data set having middle k-space rows and outer k-space rows, with said middle k-space rows being more densely disposed in said k-space data set than said outer k-space rows; reconstructing a plurality of intermediate images respectively from said k-space data sets; for each k-space data set, constructing a sensitivity intermediate image from the middle k-space rows of that k-space data set, to obtain a plurality of sensitivity intermediate images; combining said plurality of sensitivity intermediate images to form a reference image; for each of said reception antennas, determining a sensitivity profile by identifying a relationship to said reference image of the sensitivity intermediate image in said plurality of sensitivity intermediate images constructed from the k-space data set generated from the reception signal for that antenna; and combining said intermediate images dependent on said sensitivity profiles to form an overall image of at least a portion of said imaging volume.

6. A method for generating an image by magnetic resonance, comprising the steps of: emitting radio-frequency excitation pulses into an imaging volume for exciting nuclear magnetic resonance signals in said imaging volume; generating at least one gradient field in said imaging volume for location-coding said nuclear magnetic resonance signals to produce location-

coded magnetic resonance signals; receiving said location-coded magnetic resonance signals with a plurality of independent reception antennas, each having a sensitivity profile, with the respective sensitivity profiles of said reception antennas differing from each other, said reception antennas respectively generating reception signals; generating a plurality of k-space data sets respectively from the reception signals from the plurality of reception antennas, each k-space data set having middle k-space rows and outer k-space rows, with said middle k-space rows being more densely disposed in said k-space data set than said outer k-space rows, and decorrelating said k-space data sets relative to each other with regard to noise signals; reconstructing a plurality of intermediate images respectively from said k-space data sets; identifying the respective sensitivity profile for each of said reception antennas from the middle k-space rows of the k-space data set respectively generated from the reception signal from that reception antenna; and combining said intermediate images dependent on said sensitivity profiles to form an overall image of at least a portion of said imaging volume.

7. A method for generating an image by magnetic resonance, comprising the steps of: emitting radio-frequency excitation pulses into an imaging volume for exciting nuclear magnetic resonance signals in said imaging volume; generating at least one gradient field in said imaging volume for location-coding said nuclear magnetic resonance signals to produce location-coded magnetic resonance signals; receiving said location-coded magnetic resonance signals with a plurality of independent reception antennas, each having a sensitivity profile, with the respective sensitivity profiles of said reception antennas differing from each other, said reception antennas respectively generating reception signals; generating a plurality of k-space data sets respectively from the reception signals from the plurality of reception antennas, each k-space data set having middle k-space rows and outer k-space rows, with said middle k-space rows being more densely disposed in said k-space data set than said outer k-space rows; reconstructing a plurality of intermediate images respectively from said k-space data sets, and decorrelating said intermediate images relative to each other with regard to noise signals; identifying the respective sensitivity profile for each of said reception antennas from the middle k-space rows of the k-space data set respectively generated from the reception signal from that reception antenna; and combining said intermediate images dependent on said sensitivity profiles to form an overall image of at least a portion of said imaging volume.

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